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Device and Process for the Correction of the Longitudinal Registration Error that Arises due to Adjustment

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The invention relates to a process for the correction of the longitudinal registration error according to the preamble of Claim 1.

The printing of multi-color print images with rotary printing presses is done, as a rule, by the print substrate running through various inking systems in sequence, each of said inking systems imparting one color so that the multi-color print image arising arises as an overlay of several print images. Great importance is attached to the precision with which this layering is performed. Shifts of the various print images with respect to one another in the printing direction are called longitudinal registration errors. The deviations called longitudinal registration errors or the circumferential registration errors are, as a rule, corrected by the press operator at the beginning of the printing process by the press operator controlling the relative position of so-called registration marks that are applied by the various inking systems. However, this process has the disadvantage of a long reaction time and the large number of rejects associated therewith.
Thus, DE 195 27 199 proposes, in reference to a flexographic printing press, to register the registration marks with recognition sensors during the entire printing process, to supply the results of the measurement of the sensors to a control and computer unit, and to perform the longitudinal registration correction by the print cylinder being run, at least for a short

period of time, at a different circumferential speed than the impression cylinder.

In the application of the process sketched in DE 195 27 199 for the correction of the longitudinal registration error during the entire printing process, it is, however, required that said optical recognition sensors monitor the print image long-term, supply the control unit with measurement signals, whereupon the same performs the control of the speed of the various print rollers necessary for the registration correction.

This process requires, therefore, among other things, a long-term optical monitoring of the print image.

Thus, it is the objective of the present invention to propose a process that gets by without long-term monitoring.

This objective is realized by the characterizing clause of Claim 1.

The invention is based on the insight that, in proofing presses as well as in the operation of rotary printing presses, there is the necessity of adjusting the position of the rollers involved in the printing process relative to one another. In the circles of those skilled in the art, this adjustment of position is called the adjustment process.

In order to make possible this adjustment process, printing presses have suitable bearing for the rollers involved in the printing process. Thus, from DE 40 01 735 A 1 a flexographic printing press is known in which the carriages carrying the printing rollers and the carriages carrying the color application or anilox rollers are guided in a common carriage guide of the inking system bracket of the printing press and can be traversed, jointly or individually, by spindle drives.

In the case of rotary printing presses of this known type, the adjustment of the print image is normally done as follows. An electronic control device is provided that can access data input into a storage device. The data relate to the adjustment travel between the print roller and the impression roller, taking into account the geometric dimensions of the press and the diameter of the rollers.

This control device then adjusts the relative roller position so that it is supposed to be ensured that all the parts of the print image are transferred.
However, the various rollers, printing plates, the materials to be printed on, and all the other parts involved have geometrical tolerances so that an additional adjustment process often becomes necessary. This adjustment process is done by the printing press operator who adjusts the roller positions while observing the print image.

Through this type of adjustment of the print image, it is ensured that a complete transfer of the print image takes place with the lowest contact pressure of the rollers involved in the printing process against one another. Additional details relating to the adjustment process, which can run completely automatically, are contained in the still unpublished German patent application with the file number 101 45 957.2.
Along with the sketched adjustment to be performed during the contact process, it is often necessary to carry out a so-called dynamic adjustment process. By this, the following is to be understood:
At higher printing speeds changes of the effective diameter of rollers involved in the printing process occur. Affected thereby are, for example, the printing plate rollers in flexographic printing.
The printing plates of these rollers are pressed at the printing line between the printing plate and impression rollers. At higher rotational speeds, the roller no longer reaches its actual radius measured before the printing process, as the restoration speed of the flexible printing plate material is not sufficient. However, with the use of very flexible materials, it is possible that the effective diameter increases as a consequence of the centrifugal force dependent on rotary speed.
In both cases, the pressure between the rollers directly involved in the printing process changes. This situation is addressed with an additional adjustment process, the so-called dynamic adjustment. It is expedient in this connection to perform this type of adjustment automatically by a control unit determining the necessary

corrections of the relative positions of the rollers as a function of the often empirically recorded material parameters of the rollers and the printing speeds.
An investigation of the geometric arrangement of the two rollers directly involved in the printing process of an inking system yields, however, that most adjustment movements in printing presses of the known type are done along axes that do not run parallel to the connecting line of the axes of rotation of the two rollers involved in the printing process. Adjustment movements of this type thus induce a shift of the actual effective printing line on the circumference of the rollers. Each shift of the printing line leads to a longitudinal registration error.
Calculations show that the percentage of these errors that are longitudinal registration errors occurring during the printing process is significant and, in part, even exceeds the percentage of all other errors.

Thus, an effective longitudinal registration error correction can be performed with the process according to the invention without the control device being constantly loaded with evaluation and calculation operations, as in the case of the process according to DE 40 01 735 A1. As a rule, the parameters necessary to carry out the process, such as the instantaneous relative position of the rollers of the individual printing presses, are known to the known control units so that the process can be carried out entirely without additional measurement devices, such as expensive optical sensors. Moreover, it is possible to implement the process according to the invention, so that the control device only determines the correction values when changes of the relative position of the rollers have actually been made so that the calculational and control expense is also limited.

Nonetheless, the process according to the invention can be combined with other known processes. Thus, it is possible in the preregistration or at certain intervals of time to check with optical sensors, and to accordingly correct the adherence to registration. However, through the use of the process according to the invention, the necessity of constantly carrying out measurement and calculation processes is eliminated.

Additional embodiment examples of the invention are explained in the description of the object.

The figures show:

Figure 1 schematically, a flexographic printing press with a plurality of printing presses,

Figure 2 schematically, a printing plate roller in the printing process,

Figure 3 schematically, the consequences of a dynamic adjustment.

Figure 1 shows schematically the arrangement of inking systems 1 to 8 of a flexographic printing press 10 around an impression cylinder 11, where only the inking systems 1, 4, and 8 are completely represented. For the other inking systems, only the position of the printing plate rollers is specified. The inking systems are suspended on a press frame that is not represented. The inking systems n (n denotes an arbitrary one of the inking systems present) includes a printing plate roller K_n and an inking system F_n. The axes of rotation of the printing plate rollers are denoted by M_n and that of the impression cylinder by M_{11}. The lines that are defined by the axes of rotation M_{11} and D_n are denoted by S_n. Therein, D_n is the print line of the printing plate roller K_n on the impression cylinder. Between the lines S_n and the axes of the adjustment movement BA_n, angles α_n arise. The effective print line between the printing plate rollers K_n and the impression cylinder 11 are denoted by D_n.

The inking systems 1, 4, and 8 show, by way of example, various possibilities for the alignment of the inking systems or the axes of the adjustment movement BA relative to the lines S_n, while the other printing systems are merely sketched. Thus, the adjustment axis BA_1 runs on the line S_1, so that, in an adjustment, no shift of the print line results. Such an arrangement would be called a strictly linear arrangement of the inking systems. However, such an arrangement is very demanding from the standpoint of press construction and thus not to be considered relevant for modern printing presses.

An approximately linear arrangement is shown with the aid of inking system 8. The axis of the adjustment BA_8 does not run on the line S_8 and the angle α_8 arises between the adjustment BA_8 and the line S_8. Each adjustment movement of the roller K_8 leads to a shift of the effective print line D_8 on the circumference of the rollers involved, 11 and K_8.

From the standpoint of press technology and manufacturing technology, the simplest variant of the arrangement of an inking system to implement is the so-called drawer arrangement, which is shown with the aid of the inking system 4. Here, the axis of the adjustment BA_4 runs horizontally so that the angle α_4 and the registration error arising due to the adjustment is still greater than in the inking system 8.

Figure 2 shows, in the example of a printing plate roller K_9, the position of the printing plate cylinder K_9 during the printing process. The printing plate cylinder K_9 and other materials flexibly involved in the printing process, such as the unrepresented rubber coating of the impression cylinder and the also unrepresented print substrate, are exposed to strong forces in the printing process. Thus, the print plate 12 is squeezed between the impression cylinder 11 and the printing plate roller K_9 along the print line D_9. A similar process takes place on the print line 13 between the printing plate roller K_9 and the inking system F_9. In a rapid rotation of the roller K_9 about its axis of rotation M_9, it can occur that the deformation, among other things, of the printing plate on the aforementioned print lines K_9 and 13 is no longer moistened by the restoring forces of the squeezed material 11, 12, K_9, before the squeezed material once again reaches the D_9 or D_n. Thus, in this case, the effective radius R_{eff}, which denotes the distance between the outer circumference of the printing plate and the axis of rotation M_9 immediately before the repeated reaching of the print line D_9, is reduced. However, this effective radius R_{eff} is decisive for the quality of the printing process. In the case described above of the shrinking of the effective radius, the physical pressure on the print line can lessen and an effect on the ink transfer to the print substrate can occur. In this case, the press operator or the press control of a flexographic printing press will set the printing plate roller more strongly on the impression cylinder 11.

From the viewpoint of the high centrifugal forces, however, with the use of other materials, an increase of the effective radius R_{eff} can occur, which brings with it an increase of the physical pressure on the print line D_9. In this case, the printing plate roller K_9 is run somewhat further from the impression cylinder 11. In general, both processes are included under the term dynamic adjustment.

Figure 3 illustrates, in the example of a sketched inking system whose elements are provided with reference numbers without indication of the inking system enumeration, the geometric relationships if the angle α deviates from 0°.

During the contact process, the slowly rotating printing plate roller K_l has a radius R that hardly varies over its entire circumference and is positioned on the impression cylinder 11.

The position and the radius of the rapidly running printing plate roller K_s, which is represented here by a dotted line, illustrated the further course of the printing process. In the case of an increase of the printing speed, the radius, relevant for the printing process, of the printing plate roller is reduced in this embodiment example from R to R_{eff}. In order, despite this, to ensure an optimal ink transfer, the axis of rotation M of the printing plate roller is traversed from the position P_1 into the position P_2. The latter position forms the midpoint of the rapidly running printing plate roller K_s, represented as a dotted line. Figure 3 shows that the printing plate roller K_s, has, due to the adjustment process, a print line D_s with the impression cylinder 11, which, at another position, is found as the print line D_l of the slowly rotating K_l. The interval A between both print lines leads to a longitudinal registration error that is to be remedied with the process according to the invention. It is understood that the change of the radius in the course of the printing process in Figure 3 was not represented to scale for reasons of representation.

List of Reference Numbers	
1	Inking system
2	Inking system
3	Inking system
4	Inking system
5	Inking system
6	Inking system
7	Inking system
8	Inking system
9	Inking system
10	
11	Impression cylinder
12	Printing plate
13	Print line anilox roller-printing plate roller
14	
M_{11}	Axis of rotation of the impression cylinder
K_n	Printing plate roller in the inking system n
K_l	Slowly running printing plate roller
K_s	Rapidly running printing plate roller
D_n	Print line of the printing plate roller K_n on the impression cylinder
D_l	Effective print line of the slowly running printing plate roller K_l on the impression cylinder
D_s	Effective print line of the rapidly running printing plate roller K_l on the impression cylinder
A	Interval D_l - D_s
R_n	Radius of the printing plate roller
R_{eff}	Effective radius of the printing plate roller
F_n	Inking roller in the inking system n
M_n	Axis of rotation of the printing plate roller in the inking system n
$M_{n,eff}$	Midpoint of the circle defined by the radius $R_{n,eff}$
L_n	Bearing block for the rollers in the inking system n
S_n	Line which runs through the points M_{11} and D_n

BA_n	Axis of the adjustment movement of the inking system n
α_n	Angle between S_n and BA_n
P_1	Position of the axis of rotation of the slowly running printing plate roller
P_2	Position of the axis of rotation of the rapidly running printing plate roller